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Mineral resources and mining of the Spearwood and Bassendean Dune Systems

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Introduction

The development of Perth is very much dependent upon an assured access to reliable supplies of industrial minerals (sand, limestone, clay, gravel and hardrock) which are essential for road and building construction.

The *Banksia*-dominated woodlands of the Spearwood and Bassendean Dune Systems contain all the limestone resources and some of the more significant sand resources of the metropolitan region (Fig. 1).

Deposits of sand and limestone have always been thought to be abundant and freely available in the metropolitan area. These materials do occur extensively throughout the region, but the occurrence of economic deposits is limited, and proven resources are generally restricted to isolated pockets in specific geological units (Metropolitan Region Planning Authority 1984).

Sand resources

Geology

Although several geological units in the Perth area contain sandy strata, most sand supplies come from the Bassendean Sand and Tamala Limestone which form the Bassendean and Spearwood Dune Systems respectively (Fig. 1). The main areas of extraction are Wanneroo, Gnangara, Beechboro, Henley Brook, Jandakot, Spearwood and Baldivis (Biggs 1979).

The Bassendean Sand is typically yellow at depth beneath a surface cover of pale to dark grey humic sand. The sand comprises fine - to medium - grained, general subrounded quartz with occasional feldspar and heavy minerals. It is moderately well sorted with a low silt and clay content.

In the Spearwood Dune System a residual sand formed as a product of weathering of the underlying Tamala Limestone. It is humic-grey at the surface and yellow at depth, becoming orange close to the parent limestone bedrock. The sand comprises fine- to medium-grained, subangular to subrounded quartz with rare feldspar and heavy minerals, and is moderately well sorted with a small, but significant, clay and silt content. In general, it is coarser than the Bassendean Sand but the difference is slight and cannot be detected in all samples.

Uses

The major use of sand in Perth is for land fill - freeway construction, bridges, housing pads and rubbish disposal by sanitary land fill all require sand filling. Sand is also used as bedding for pipes to prevent damage, especially in the hills area where soil movement may cause problems. Standard specifications require that the sand be free of vegetable matter.

Construction sands - those used in concrete, brick work and plaster - need to meet a set of standards relevant to their end use. These standards set permissible percentages of various grain sizes, the rate of water absorption, particle shape, and the amount of contained impurities.

In Perth the most valuable sands are those with a high silica content, such as those found in the Gnangara and Jandakot areas. These are exported to Japan for glass manufacture and for some types of moulding, and to the Philippines for cement manufacture.

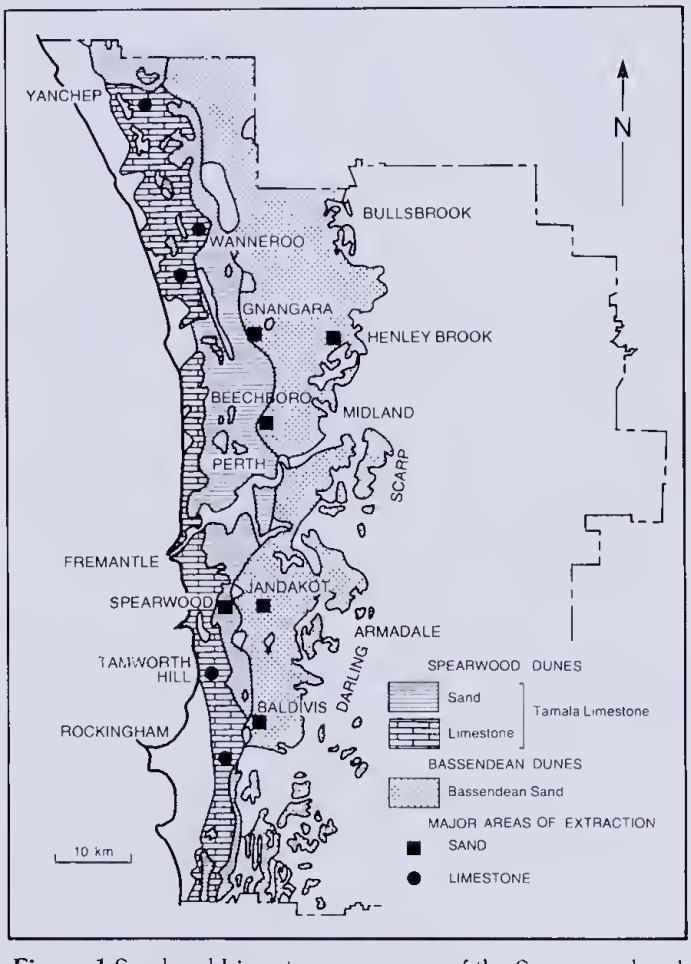

Figure 1 Sand and Limestone resources of the Spearwood and Bassendean Dune Systems

Mining and treatment

Because large areas of Perth are built on sand, there is a generally held belief that supplies of sand are cheap and unlimited. However, as urbanization advances, potential resources are sterilized, existing pits are forced to close and relocate, and transport costs increase.

In 1986 there were 49 actively worked sand pits in the metropolitan area. These were worked by a total of 32 operators, many of whom operated pits on a full time basis. The remaining pits were worked on an ad hoc basis according to the operators' needs. It is partly due to the simplicity of pit operation that the number of operations is high and ex-pit prices are very low.

Sand is the least expensive of all raw materials to extract, and the simplest to exploit. A typical operation involves a dozer, a front-end loader and a screening plant.

Once the vegetation is cleared, the overburden is stripped and stockpiled for future rehabilitation. In the case of sands not requiring treatment, the sand can be loaded directly from the pit face to the truck. Construction and other specialized sands usually require either dry screening or washing to remove organic matter and oversize material.

Limestone resources

Geology

The Tamala Limestone contains all of the limestone resources of the Perth region (Gozzard 1987). It occurs as a series of ridges parallel to the coast, and most is dunal in origin although marine beds are also present. The limestone typically ranges between 50% and 90% calcium carbonate ($CaCO_3$). The magnesium content is normally low, ranging from 0.5% to 1.5% $MgCO_3$, but in exceptional cases it may be as high as 3% $MgCO_3$. Silica (SiO_2), in the form of quartz grains, is the only significant contaminant and usually exceeds 12% of the rock. Average concentrations of minor constituents are: 1.1% Al_2O_3, 1.1% Fe_2O_3, 0.5% K_2O, 1.14% Na_2O, and 0.013% Cl. The *in situ* moisture content is normally about 5%.

The higher grade material is only found in isolated pockets within two areas. One is between Spearwood and Tamworth Hill, and the other is to the north west of Wanneroo (Fig. 1).

Uses

There are three industries that require high-grade limestone and cannot function with any substantial proportion of lower grade calcium feed. These are cement manufacture, lime production, and iron and steel smelting. The main use for high-grade material is in cement manufacture, which requires limestone with a $CaCO_3$ content of at least 80%.

Currently the two cement companies (Swan Portland Cement and Cockburn Cement) operating in the metropolitan area use this rock to produce at least 600 000 tonnes of cement annually.

The main uses of low- and medium-grade limestone include soft material for building, hard caprock for groynes and breakwaters, and rubble for road construction.

Mining and treatment

In 1986 a total of 24 operators had licences issued by local authorities to extract limestone within the metropolitan area. These operators include three local authorities and the Main Roads Department. Six of the operators had interests in three or more sites. In addition there are approximately 100 mining tenements for limestone extraction within the metropolitan area.

The quarrying of limestone generally proceeds in stages, the first of which is the removal of overburden. This material, consisting principally of uncemented silica sand and variable quantities of caprock derived from limestone pinnacles, is normally used for the restoration of worked out areas. Initially the overburden is stockpiled, but, as the quarry is developed, all overburden is transferred directly into the worked-out areas to effect progressive restoration, thus avoiding double handling. Following this, weathered limestone is removed to expose the usable material.

Whenever possible, higher and lower grade materials are blended in order to extend the life of a quarry but this practice is too expensive when the quarry is yielding only low- and medium-grade material. Low-grade limestone can be mixed with binders such as bitumen, lime, clay, fly ash, and Portland cement, and used in road construction.

Environmental Aspects

Approval to operate sand or limestone pits depends on the proposed use of the material and the tenure of the land. These factors will determine whether the operations are approved under the Mining Act or under the Extractive Industries By-laws of Local Government. If the location is in an area that is environmentally sensitive approval may also be required from the Environmental Protection Authority.

In all cases the proponent is required to prepare a mine plan, operational guidelines, final landform and a rehabilitation program. The final landform and method of rehabilitation depends very much on the final use envisioned for the site.

In some cases pits have been used for landfill waste disposal sites and in other cases suburban development has occurred over worked-out pits. In recent months an old limestone pit north of Wanneroo, which was in operation before the creation of the Neerabup National Park, has been re-contoured and rehabilitated to encourage forest regeneration to a standard acceptable for return of the area to National Park status.

The environmental aspects of these types of extractive industries are presently under review by a Government Committee into Conservation and Rehabilitation in the Mining Industry. This committee will formulate recommendations aimed at ensuring that basic raw materials supplies are always available while ensuring that final landform objectives are met.

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